

# Frisbee

Even the least athletic of teenagers enjoys throwing Frisbees but few know anything about the toy's history and less still about how it flies. The name comes from the Frisbie Pie Company who made pie plates which in the late 1800's students at Yale University discovered had unusual aerodynamic characteristics. That is, these pie plates could be sent into a flying spin fairly easily. The rest is history! Part-time inventor Fred Morrison experimented with the saucers and made some models by pressing plastic into the disc shape. Eventually he sold his design to Wham-O Toy Company who marketed the disc so successfully that the toy is ubiquitous today. But the question we want to answer is how does the Frisbee fly? We'll examine the aerodynamics of this object by exploring the following questions:

- What happens if you throw a Frisbee without any spin?
- How does the angle of release effect the flight of the Frisbee?
- Do the ridges on the Frisbee affect it's flight?

## **Question 1:** *What happens if you throw a Frisbee without any spin?*

### **Introduction**

Once you learn to throw a Frisbee it can seem such a natural action that you forget entirely that when you began you had to be told to spin the disc as you released it. You probably no longer recall what happens to the flight of the Frisbee if you throw it a different way just as you can not recall how difficult it first seemed to balance yourself on a bicycle. Let's do an experiment to reexamine why we put spin on a Frisbee as we release it.

### **Equipment Needed**

1. Frisbees
2. Video camera
3. Measuring tape

### **Procedure**

1. Have an experienced Frisbee thrower throw the disc naturally and then throw the disc without imparting any spin to it on release.
2. Videotape the throws.
3. Measure the distance the Frisbee travels before it touches the ground.
4. Average the distance traveled for both the spinning and nonspinning disc.

### **Analysis/Questions**

1. Examine the video you made of the Frisbee thrown both with and without spin.
2. Describe the flight of the Frisbee in both cases including the distance attained, the trajectory, and any other observable characteristic.

## **Question 2:** *How does initial angle of release effect the flight of a Frisbee?*

## Introduction

From the first experiment you no doubt discovered that a spinning Frisbee has a much more stable flight. The reason is that any spinning object conserves angular momentum. That is, like a gyroscope or top, a Frisbee resists any change in its orientation. This stability keeps the Frisbee from tumbling rather like the spiral spin helps a football stay on a parabolic path. Now we want to look at how the angle of release, defined as the angle between the plane of the Frisbee and a parallel to the ground, effects the flight of the disc. In doing so we will need to understand a bit about the concept of lift. Lift occurs when the air moves over an aerodynamic shape like an airplane wing. The air must move faster over the topmost curved surface which lowers its pressure. Since the air pressure on the bottom is then higher than the air pressure on the top, a push upwards occurs. We call this phenomenon lift and we can thank it for the flight of many objects. Let's look closer at the flight of the Frisbee by doing the following experiment.

## Equipment Needed

1. Frisbees
2. Measuring tape
3. Protractor
4. Level
5. Video camera

## Procedure

1. Have an experienced thrower hold the Frisbee at a natural, ready-to-go attitude.
2. Use a leveling tool below the Frisbee to measure the angle between the plane of the disc and a parallel to the ground.
3. Video tape the Frisbee as the thrower releases it with normal effort. Measure the distance the disc travels before it hits the ground.
4. Now have the thrower increase his/her angle of release and throw again.
5. Repeat this procedure several times. Be sure to video tape each throw and measure the flight distance.
6. Record the data on the table below:

| Angle | Distance traveled |
|-------|-------------------|
|-------|-------------------|

## Analysis/Questions

1. Examine the video tapes and determine how the angle of release affects the flight of the disc.
2. Plot a graph of angle of release versus distance traveled. Is there any relationship that you can determine?
3. Research the concepts involved and explain what you saw in the video tape and graph.

**Question 3:** *Do the ridges on the Frisbee effect its flight?*

## Introduction

Inventor Fred Morrison spent years designing these flying discs and demonstrating them at county fairs and other events. The Wham-O company made further design improvements after buying the toy idea from Morrison. But do those ridges on the top of the disc really matter in terms of flight efficiency? We'll perform an exercise to see.

## Equipment Needed

1. Frisbees: normal and with ridges sanded off
2. Measuring tape
- video camera

## Procedure

1. Have an experienced thrower toss both types of discs with normal effort.
2. Measure the distance traveled for several flights.
3. Record the information on the table below. Be sure to also video tape all the flights.

| Type of Frisbee | Distance traveled | Comments |
|-----------------|-------------------|----------|
|-----------------|-------------------|----------|

## Analysis/Questions

1. Average the distance traveled for both types of discs.
2. Was there any real difference between the distance achieved between types? How can this conclusion be explained?